Cushion use and performance in everyday life

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Or
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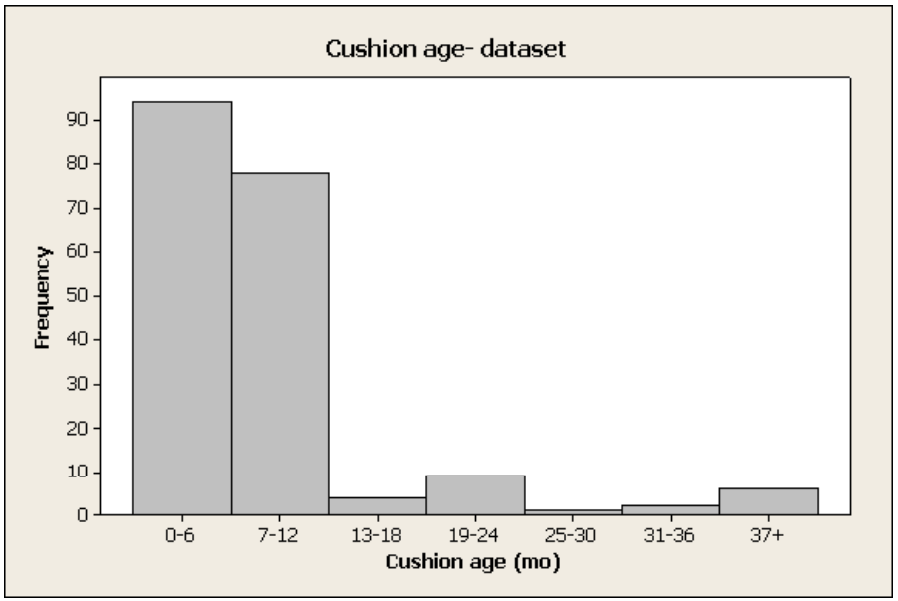
Understanding the State-of-Use and Perfomance

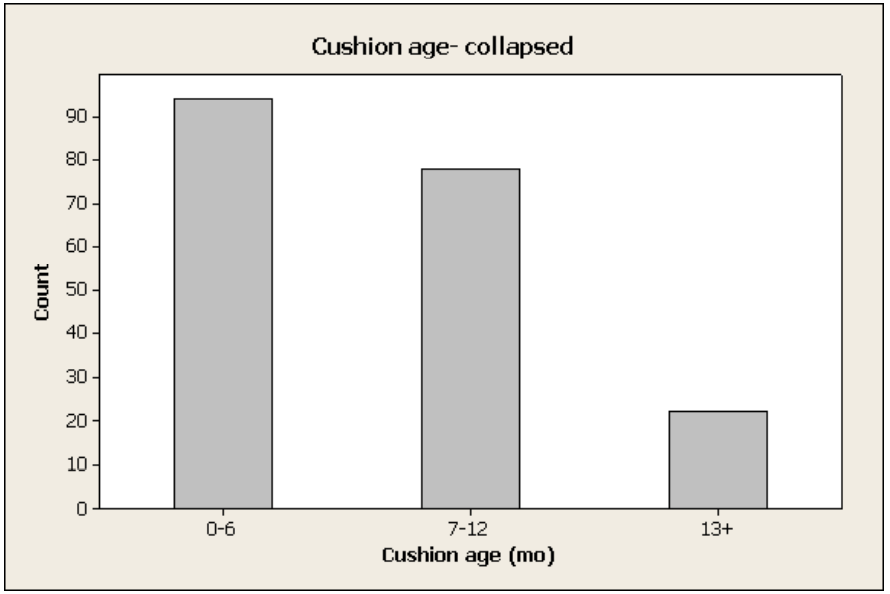
- Surveying used cushions
- Documenting degradation
- Temperature and humidity
  - Controlled tests
  - Within everyday use

Surveying used cushions

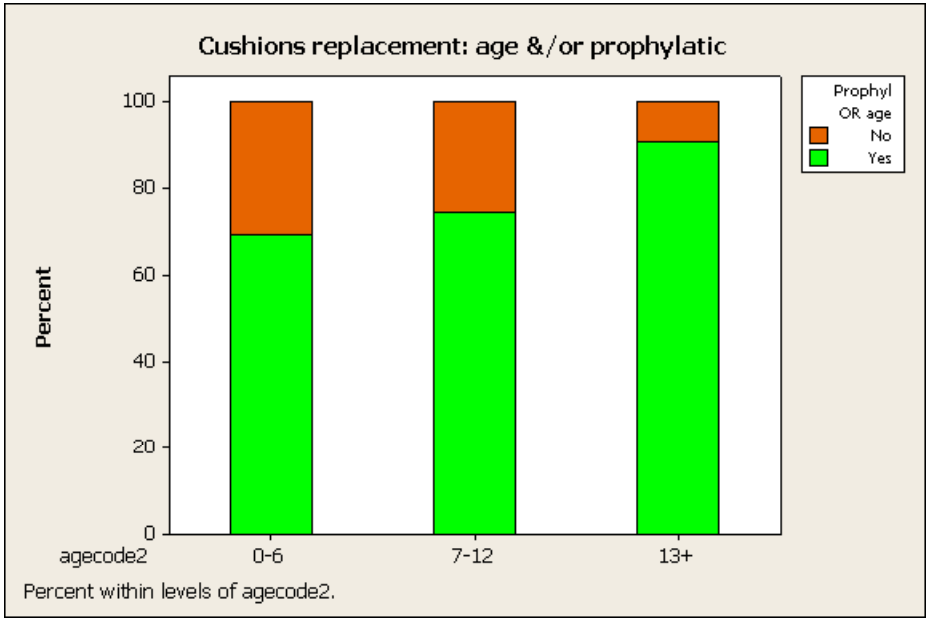
- Survey developed to document cushion status
  - Cushion construction
  - Reasons for replacement
  - Cushion & cover inspection
    - Damage, fatigue, failure
- Sent to Robert Bingham in Australia
- 209 surveys completed
- Flat and contoured foam

Age of foam cushions (n=209)

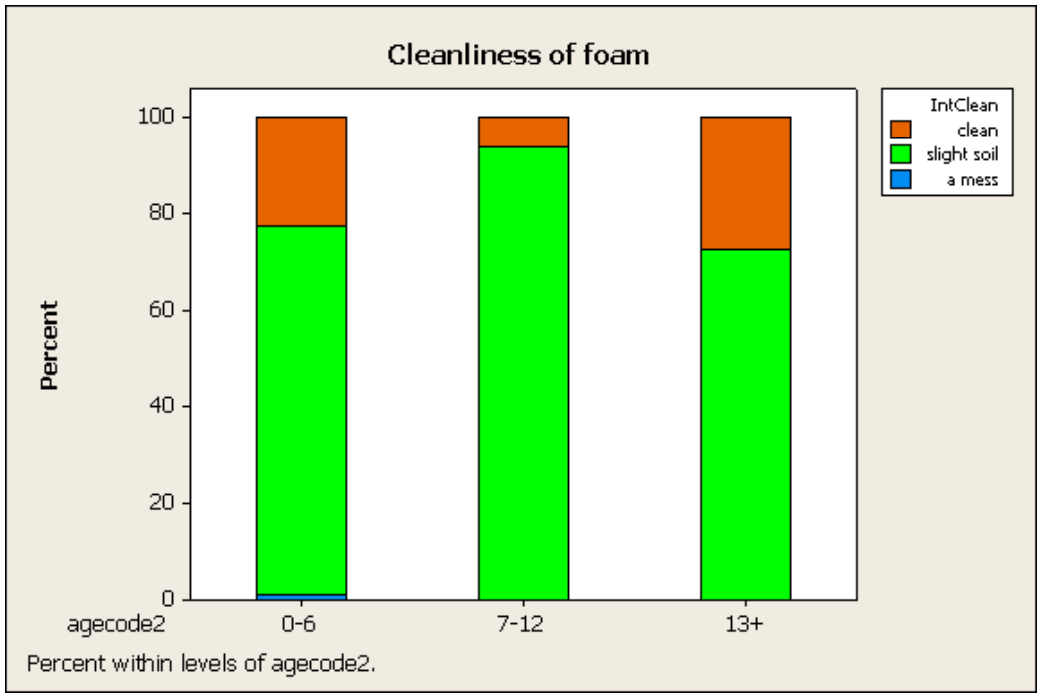




90% were <12 mo old

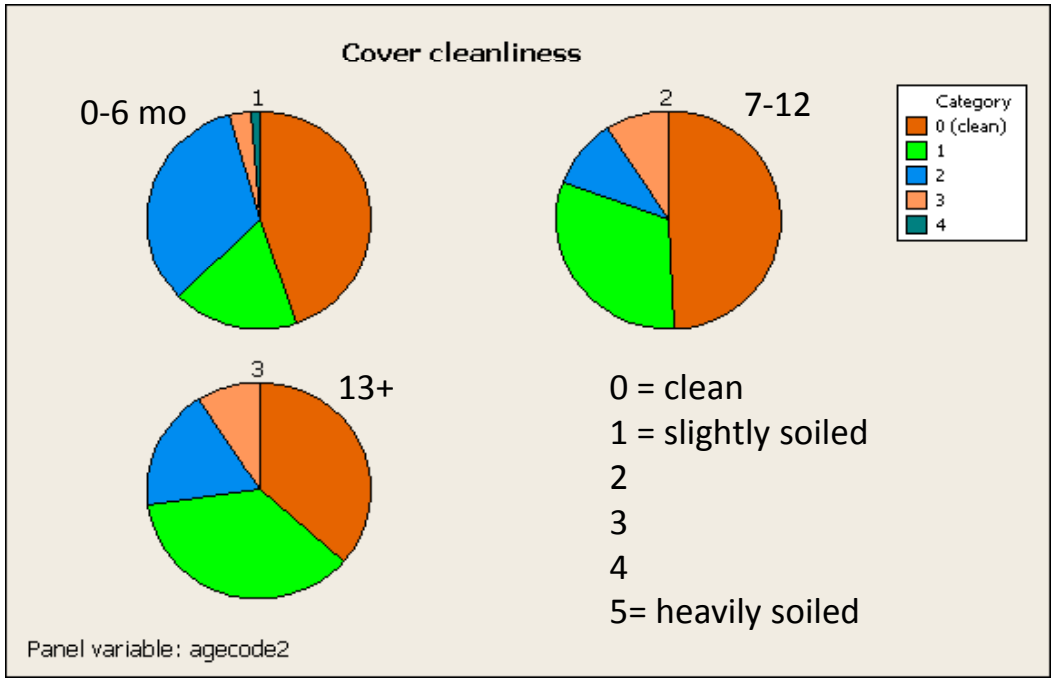


Majority of cushion replaced because of their age



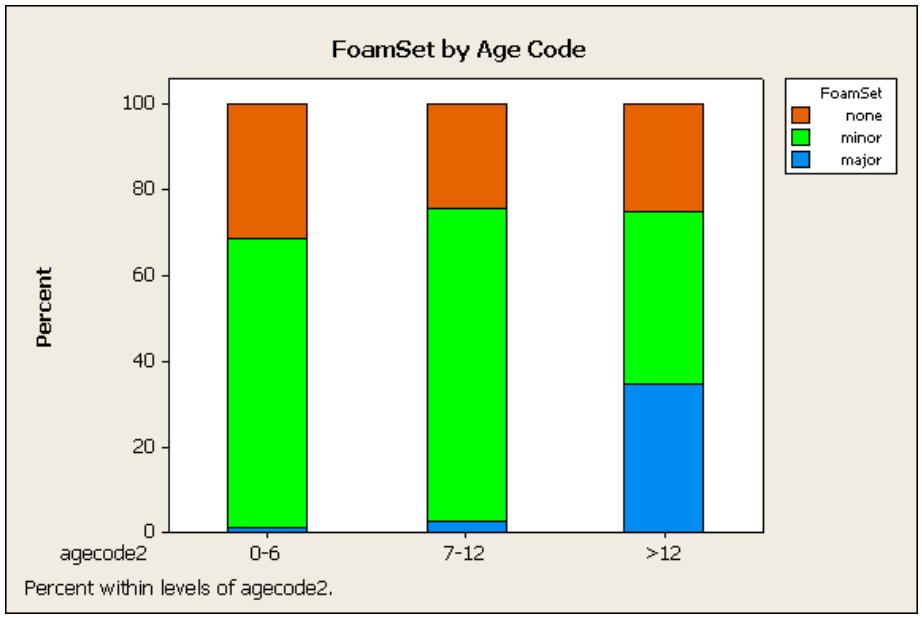
All- but 1- was deemed ‘clean’ or ‘slightly soiled’

>60% of covers deemed ‘clean’ or ‘slightly soiled’



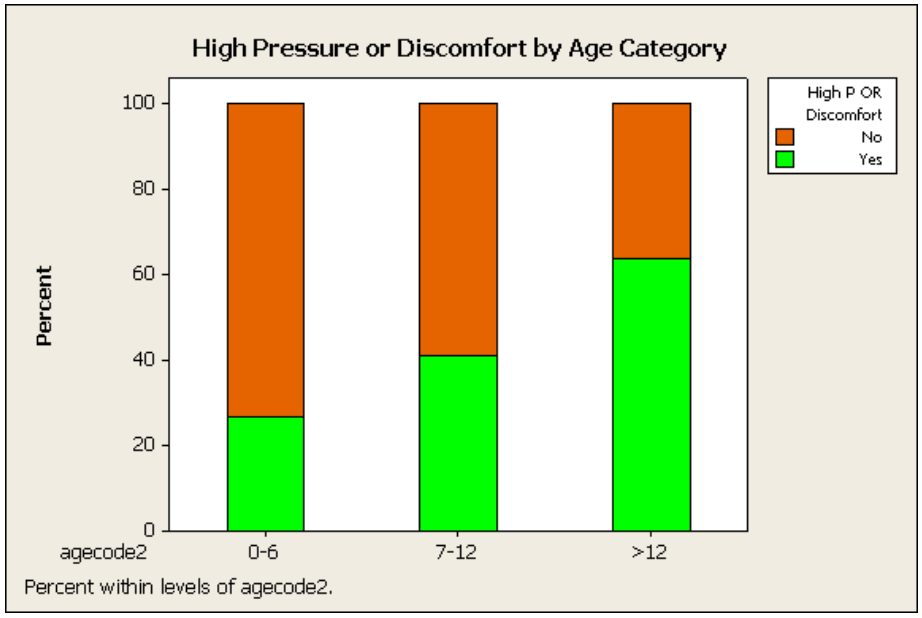
0 = clean
1 = slightly soiled
2
3
4
5= heavily soiled

Physical and clinical signs of fatigue



After 6 months, 70% showed *physical* signs of fatigue

Compression set: when a material fails to return to its unloaded state



40% of cushions 7-12 mo of age showed *clinical* sign of fatigue

>12 months, >60% showed a clinical sign

Why we should care

- Nice size data set on foam cushions
  - *Opportunity to use peer pressure to collect more data*
    - Hopefully, on different types of cushions
- Insight into a different delivery model
- Compression set occurs before clinical indicators of fatigue
  - High pressures or discomfort noted for 33% of cushions ≤12 mo
  - Compression set noted in 70% of cushions ≤12 mo

Conclusion

- Foam is in pretty good shape after 12 months of use
  - Australia should be commended for this model
- Certain temporary wheelchair users may benefit from a foam cushion
  - i.e., stroke survivors are often d/c'd with orders for only a wheelchair; minimal cost might meet needs

Documenting degradation

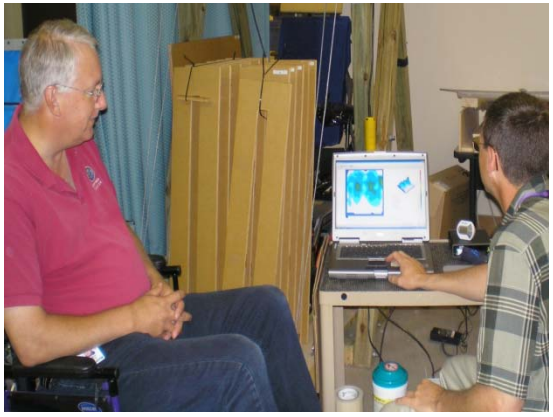
a collaborative project between

- Objectives
  - Identify the expected lifespan of cushions and the significant predictors of cushion failure
  - Develop and validate a clinical measure of seat cushion degradation
- 138 different cushions studied (24 measured >1x)
  - Most common: 32 Jay2; 26 Roho HP; 14 Evolution
- Client eval, visual inspection & performance measures
- Mean age: 24 months (range: 1 day to 168 months)

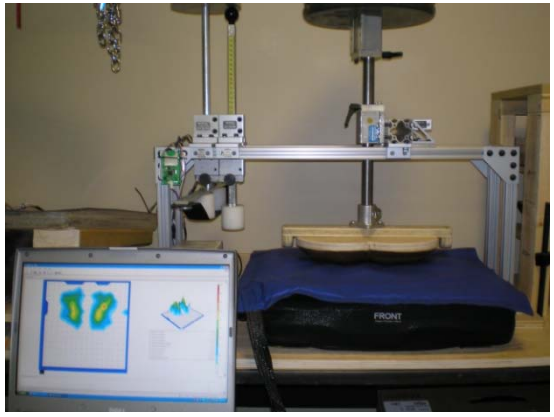
Testing cushions over time

Interview & physical exam

IPM with user

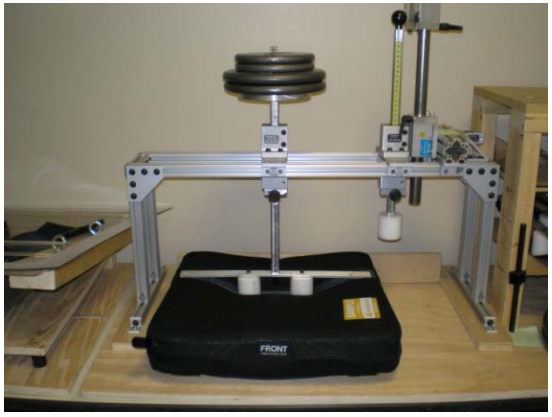


IPM using model



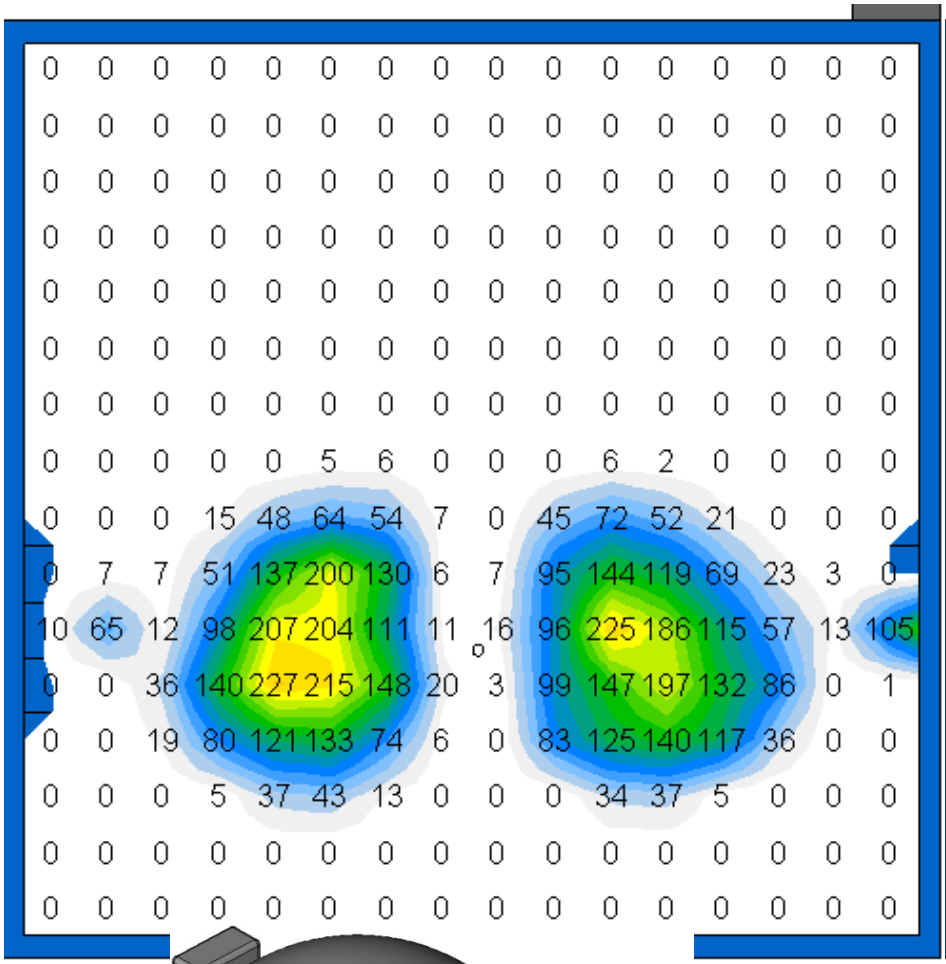
Visual inspection & dimensioning

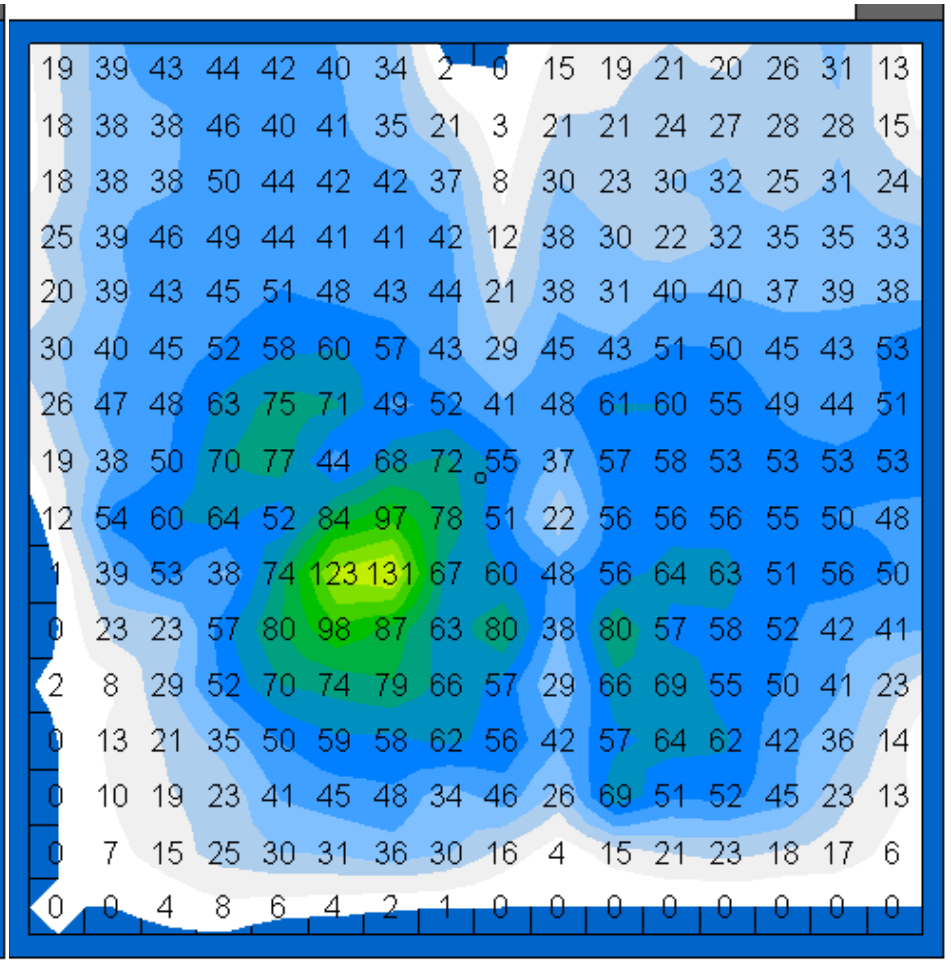
Loaded contour depth

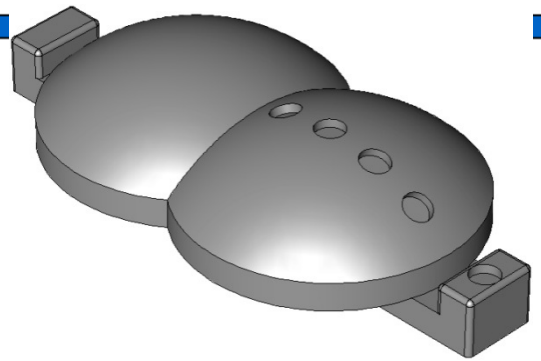


Impact dampening

Model and Human IPM

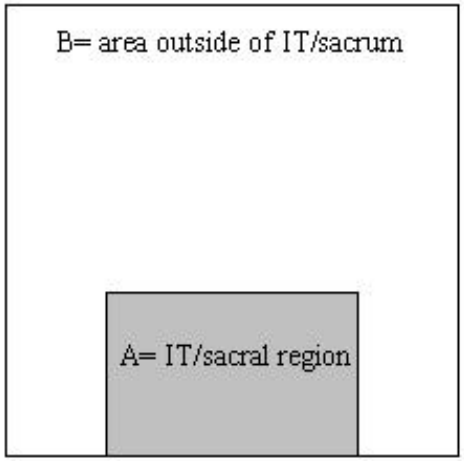




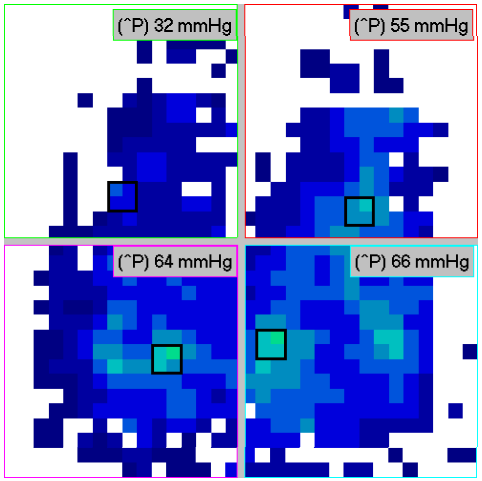


<u>Metrics cover:</u>
magnitude
asymmetry
dispersion

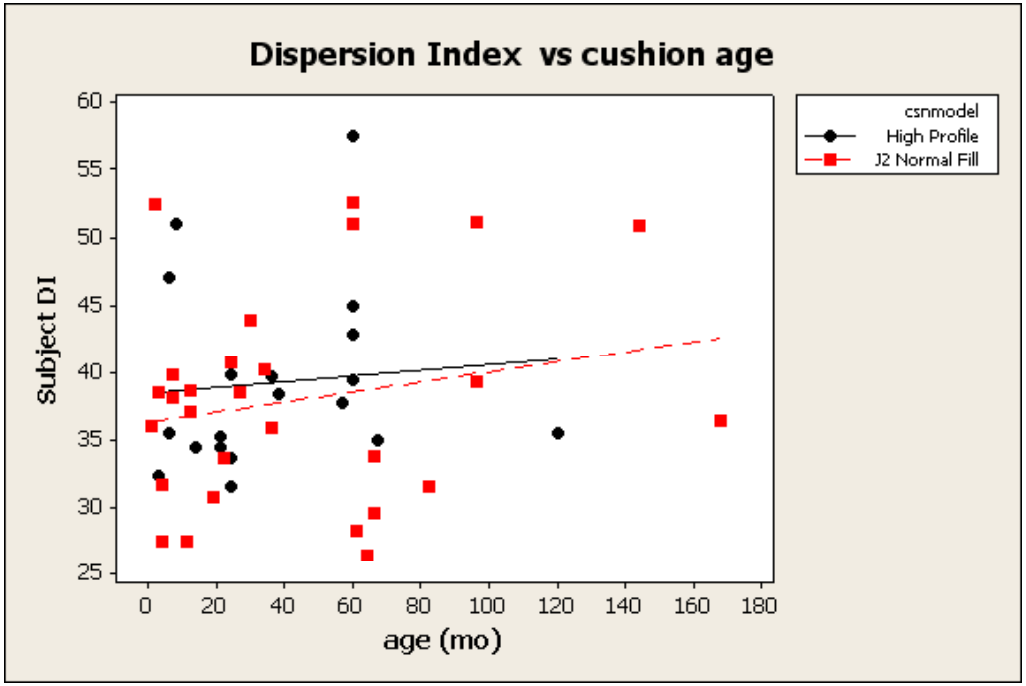
Look only at ROHO and JAY2

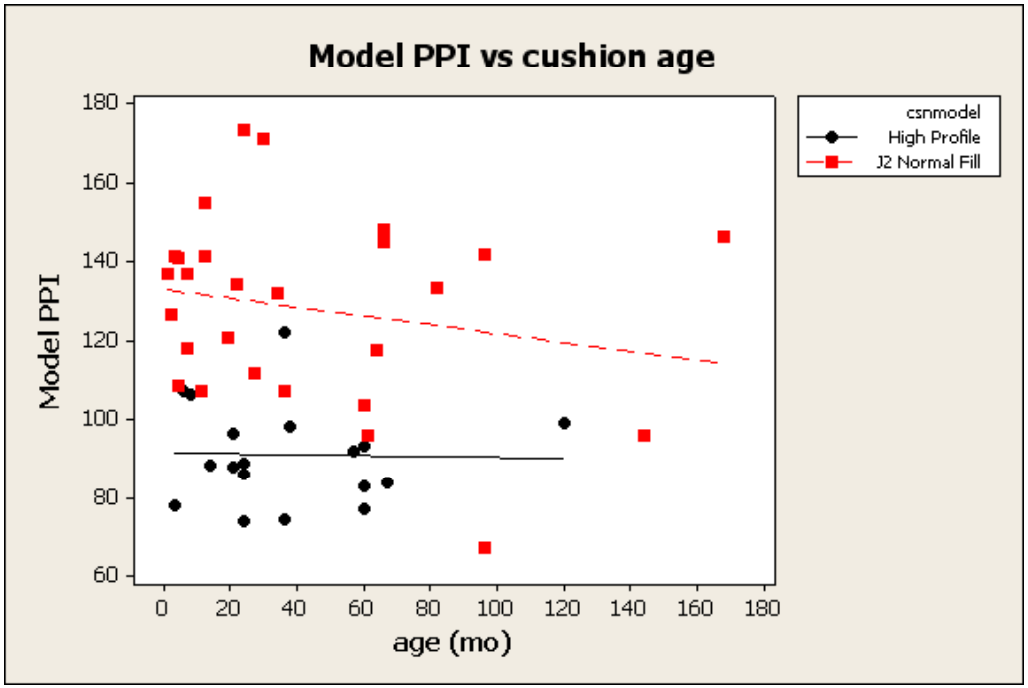


DI= ratio of IT pressures to total pressure

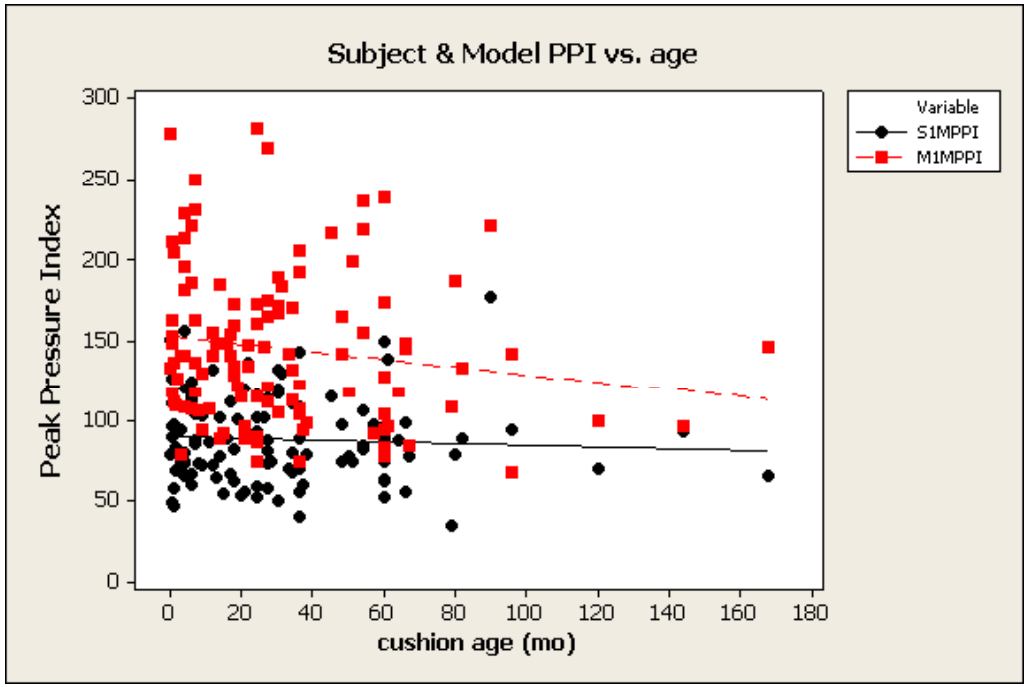


PPI= measure of pressure magnitude

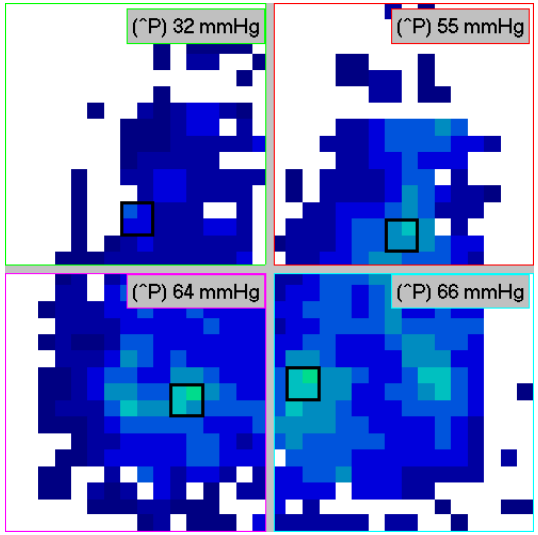




Pressure magnitudes- ALL 162 cushions

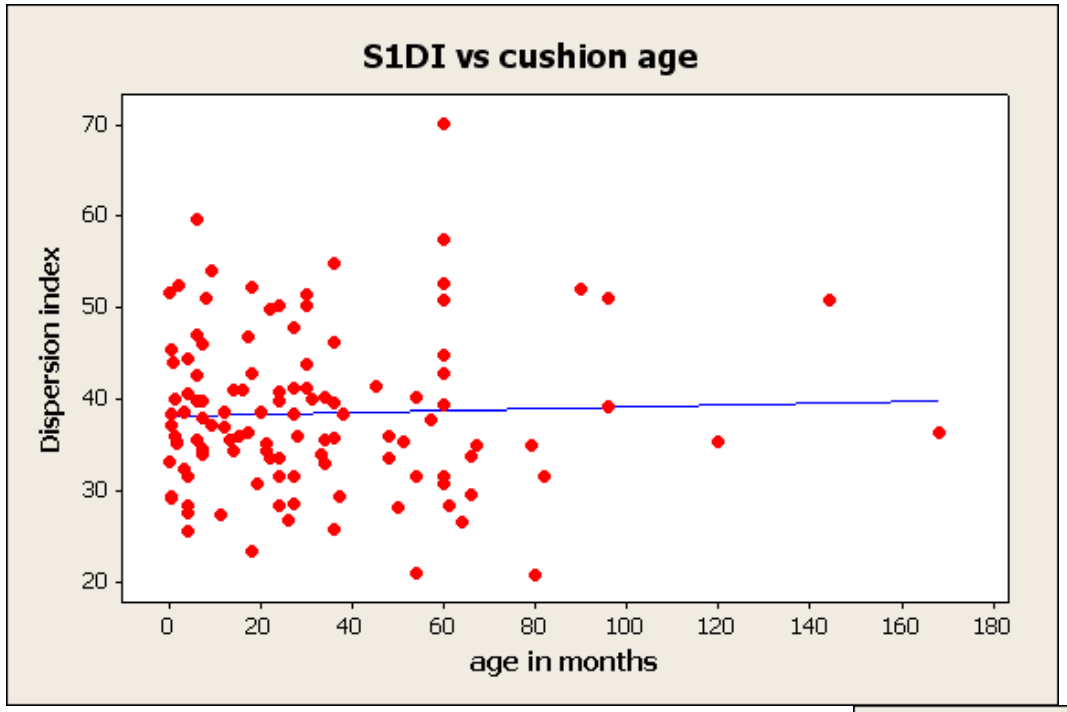


Both model and subject pressures indicate NO relationship over time



Black: IPM using buttock model
Red: IPM using cushion user

Look at variability of **red** model data compared to variability of **black** subject data

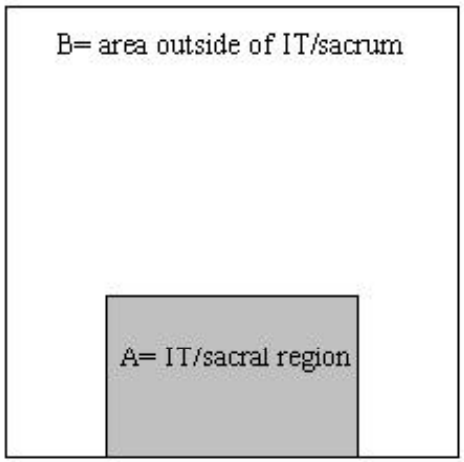


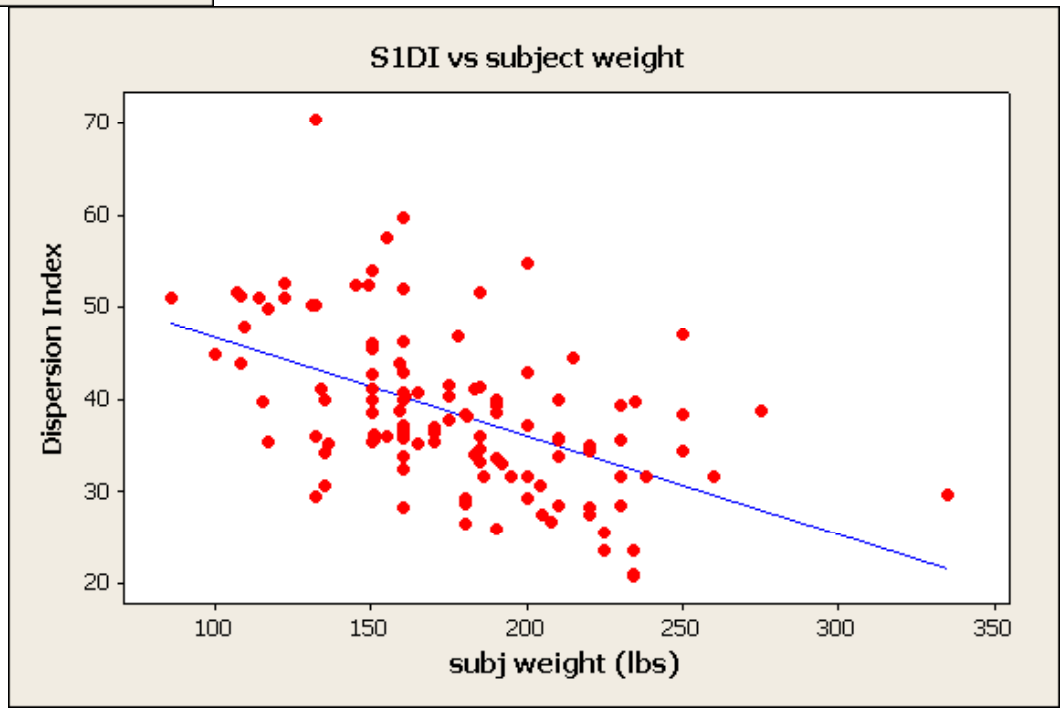
A tale of 2 predictors

Cushion age

Subject weight

Dispersion Index (DI)

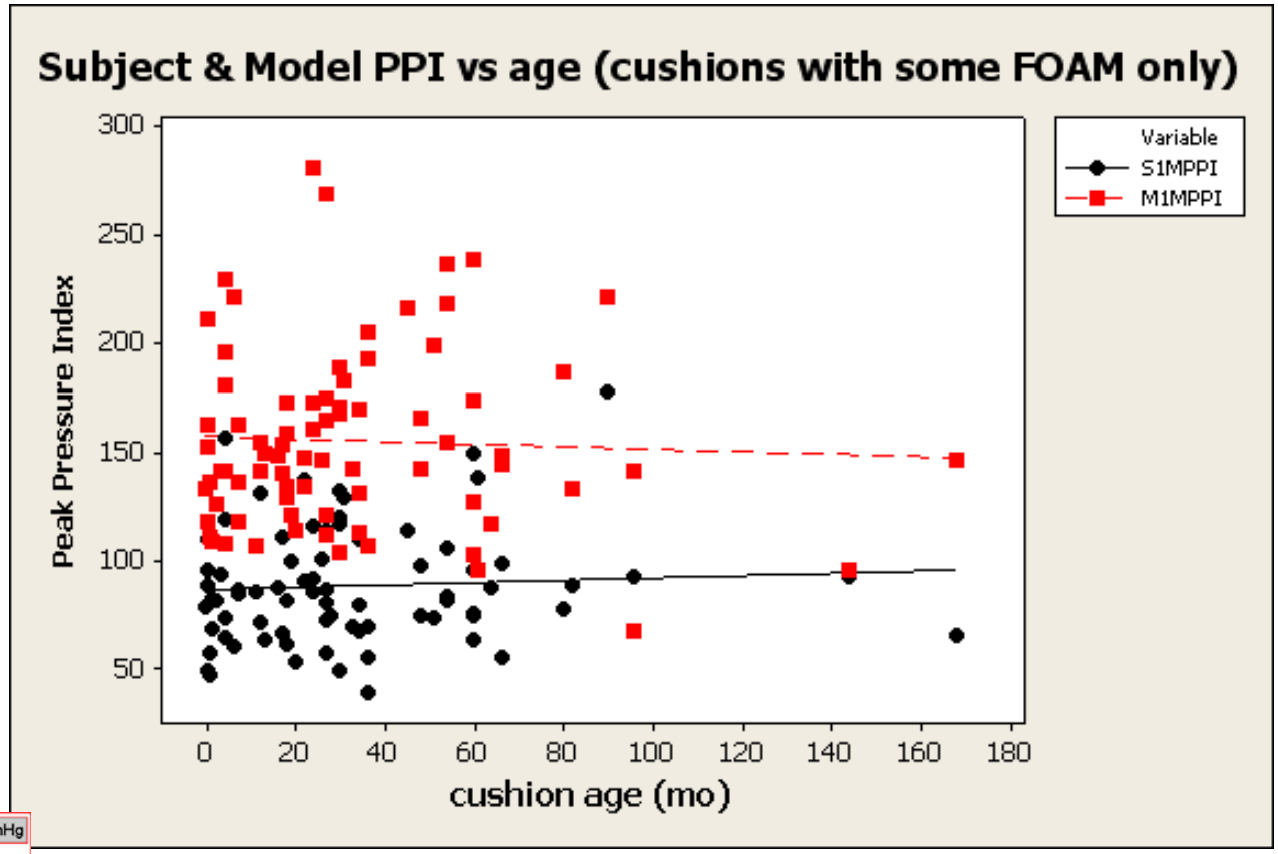


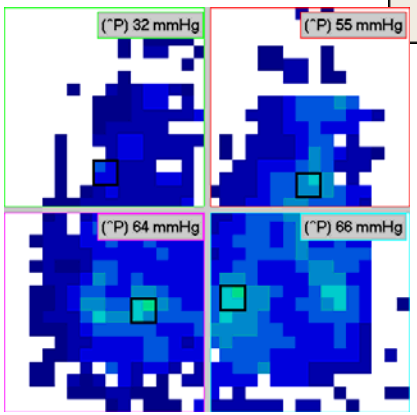


In fact….

- **Cushion age** has *not* been able to predict any IPM-related variable
  - For all cushions
  - Combining the 3 most tested cushions (Roho, Jay2, Evolution
- Regression reported cushion age has a weak performance relationship within *Evolution*
  - *May be indicative of foam*

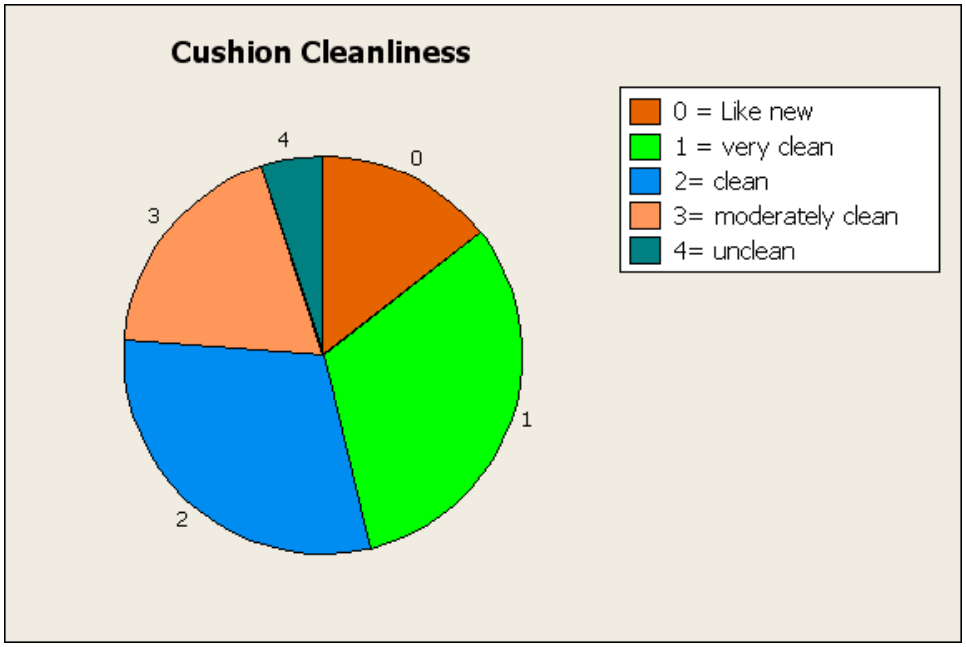
Looking only at FOAM-based cushions



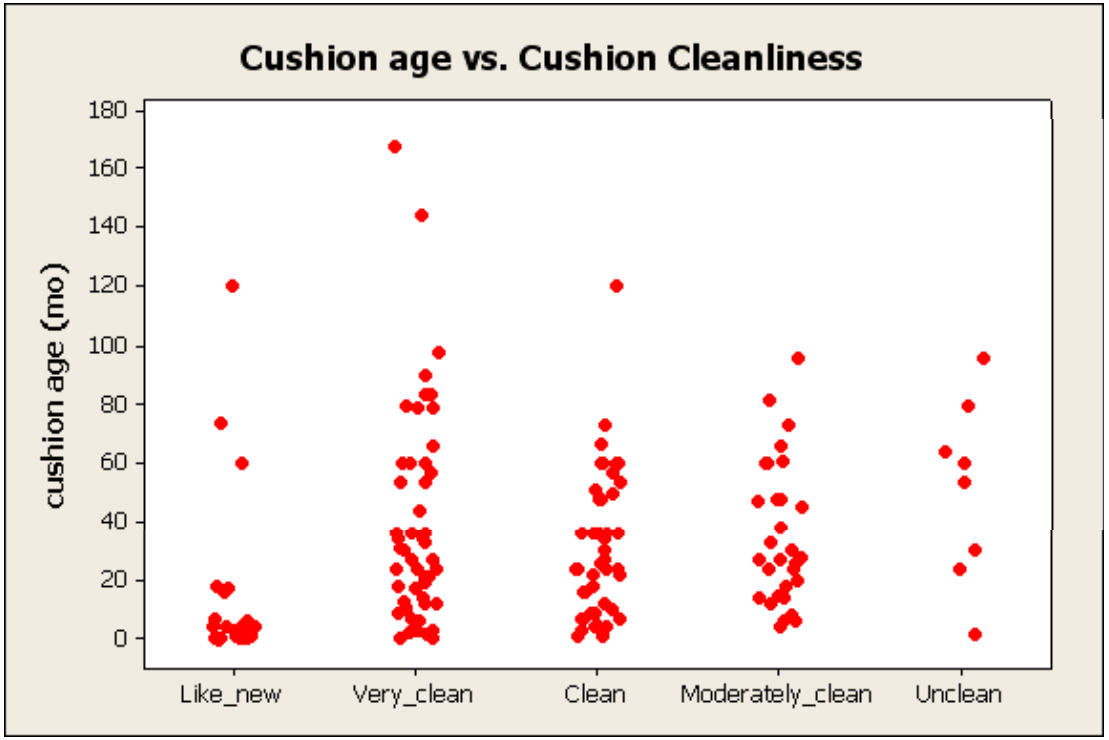


No relationship with age
Huge variance in model testing

Cushion Cleanliness



About ¾ of cushion deemed ‘clean”
‘Unclean’ cushions ranged in age



Clinician's perception of cushion adequacy

"is the cushion good enough for the client to use?"

- Clinician's are 5 ½ times more likely to judge a foam cushion as *inadequate* compared to a non-foam cushion
- Clinician's were 3 times more likely to judge a '*clean*' cushion as '*adequate*' than one judged '*moderately clean*' or '*unclean*'

Why we should care

- Tracking performance changes over time is needed to better understand “useful life”
- We need a means to identify cushions that need to be replaced
- Extensive data on 138 cushions is overwhelming
- Evidence suggests that Roho and Jay 2 cushion performance appears independent of age
  - For the cohort studied
- Cushion usage is individualistic so identifying a global measure of fatigue is very difficult
  - As always, individualistic evaluation is indicated

Temperature and humidity

- Humidity represents moisture
- Temperature represents temperature

Both have impacts on tissue integrity

Friction and Moisture

- As moisture increases, friction increases
  - ↑ softness → ↑ contact between surfaces
  - Want to learn more?- see cosmetics literature
- Excessive moisture weakens skin's ability to withstand load

Temperature and it's impact on tissue viability

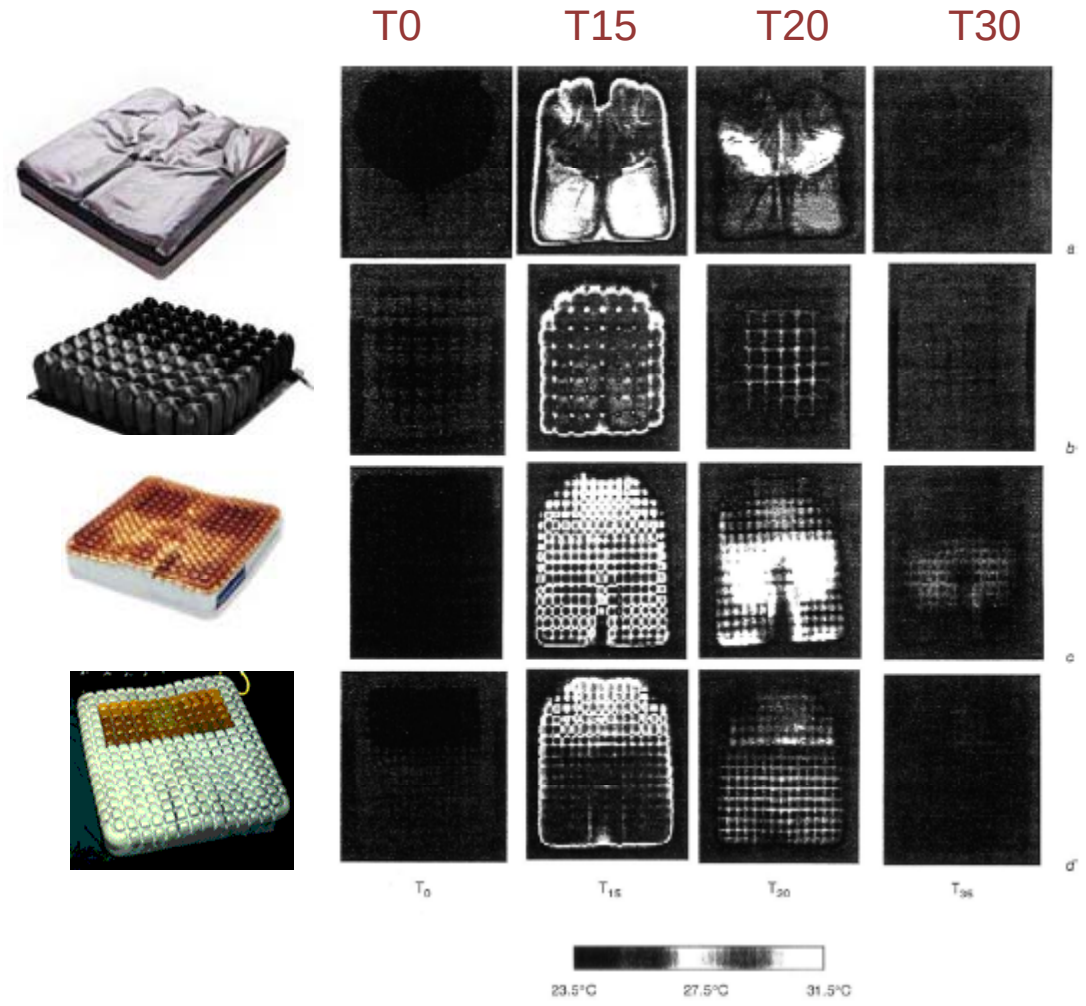
- ↑ tissue temperature ↑ metabolic demand
  - Added demand coupled with reduced nutrient delivery leaves tissues vulnerable
- Evidence suggests that reduced temperature has protective influence
  - Kokate (1995)
  - Patel (1999)
- Kokate: "At a given pressure, … lower temperatures exert a significant protective influence with respect to the development of pressure ulcers"

Temperature and pressure

- Lachenbruch (2005)
  - 2nd analysis of published data
  - 8ºC decrease in skin temperature is equivalent to a 29% reduction in interface pressure
  - Rightly advocates attention to skin temperature

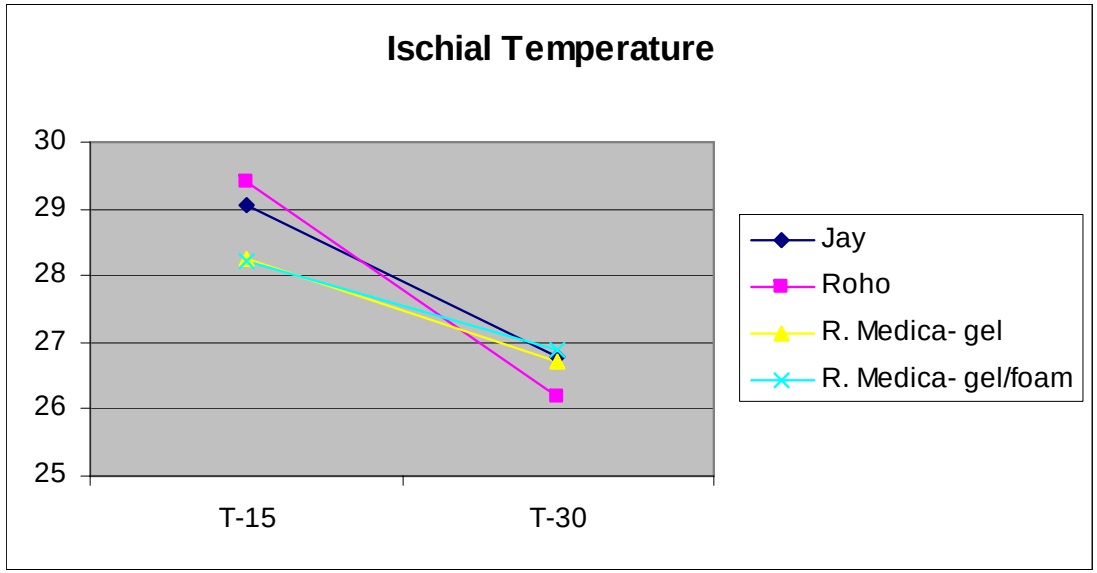
Controlled testing- Ferrarin & Ludwig, 2000

- Sequence of images taken
  - Before sitting (T0)
  - After 15 of sitting (T15)
  - 5 & 15 minutes after transfer (T20 & T35)



Controlled testing- Ferrarin & Ludwig, 2000

Roho heats the most and cools the quickest (*steepest slope*)
R. Medica gel retains heat the most (*lowest slopes*)



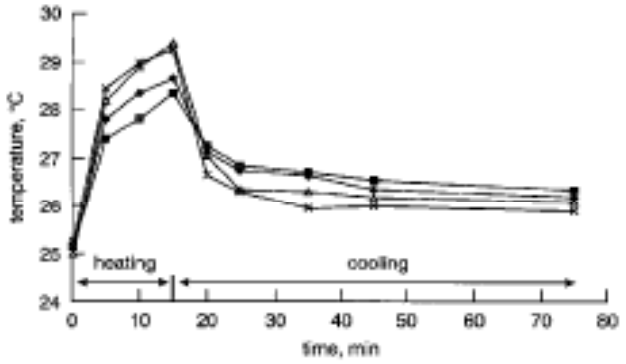


Fig. 2 *Average surface temperature (T_{av}) against time for each cushion*
△ *cushion A*
× *cushion B*
■ *cushion C*
◆ *cushion D*

What's one limitation of the study and conclusion

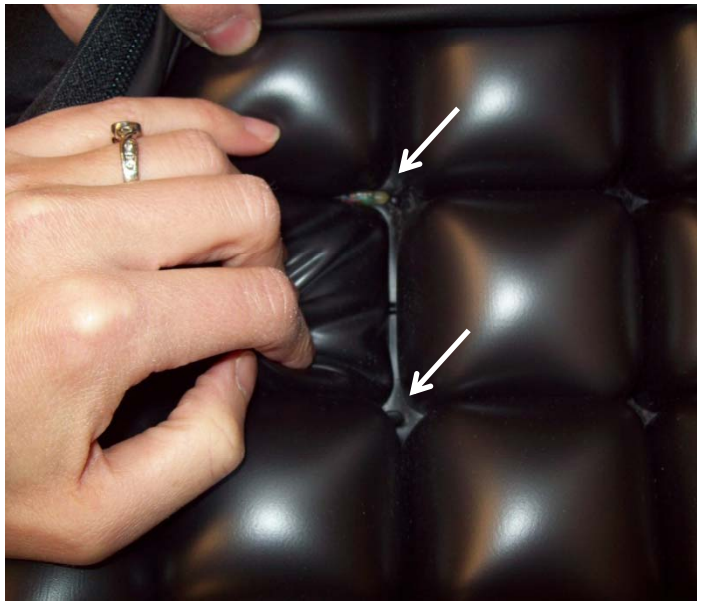
Logging temperature & humidity

Controlled testing

Monitoring daily life

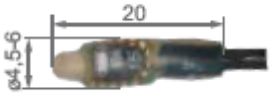
MSR data logger

- Accuracy
  - ± 0.1 °C
  - ± 2% RH
- Inserted temperature and humidity sensors at cushion interface under buttocks



External temperature sensor

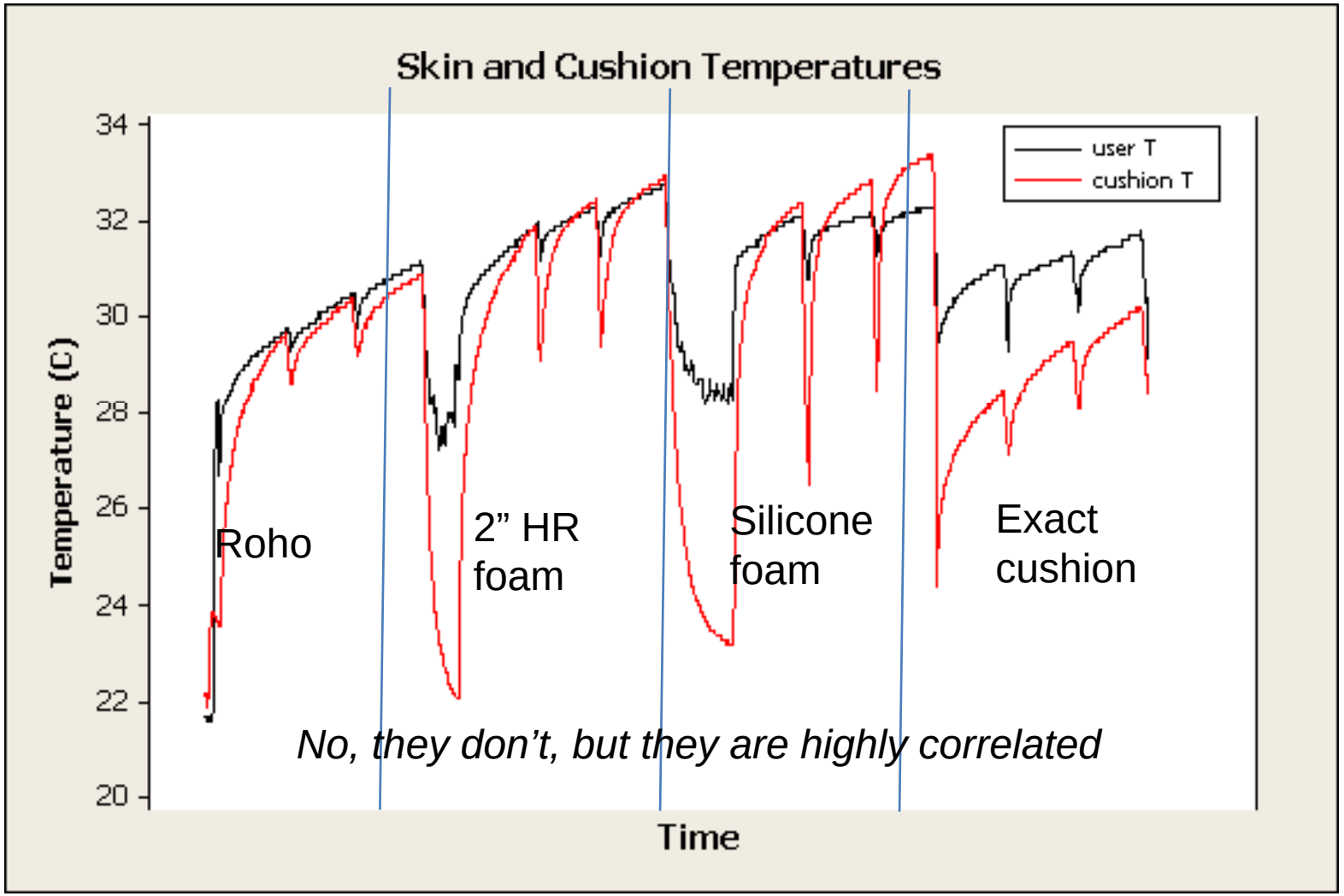
External humidity sensor



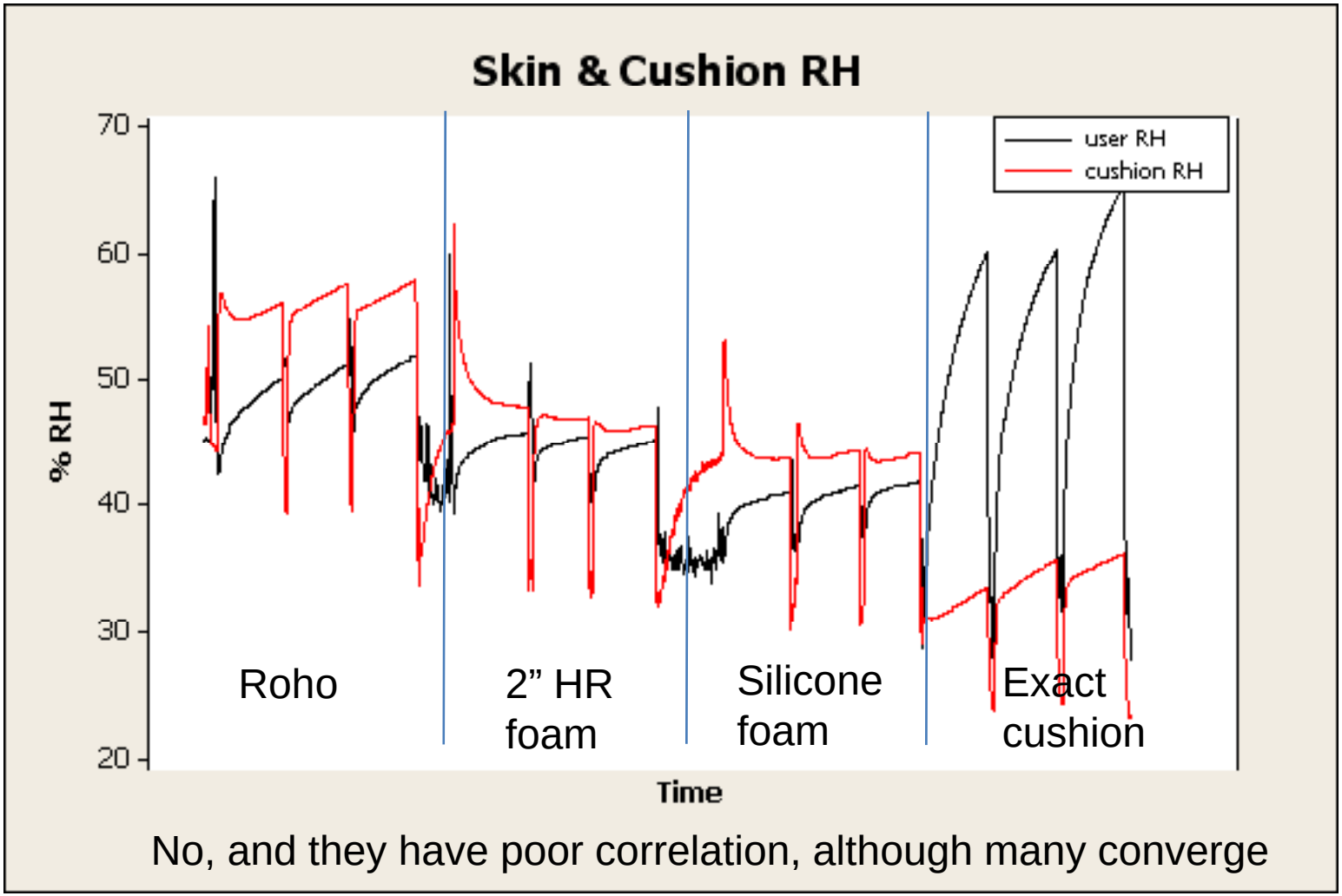
20 x 15 x 61 mm

1st question?:

Do skin interface temperatures equal cushion interface temperatures?



Does RH at skin interface equal cushion interface RH?



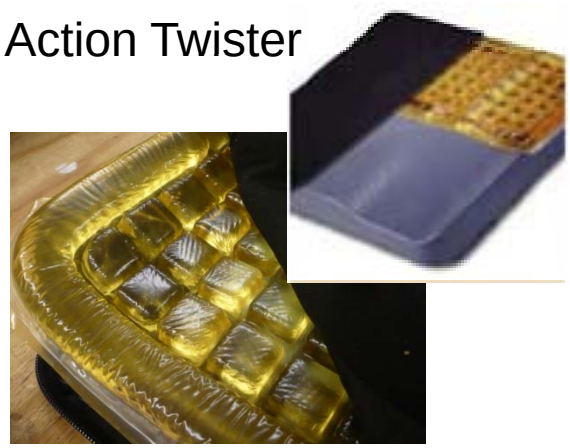
No, and they have poor correlation, although many converge

Controlled 45 min test- 4 cushions

Same subject; same clothes, same room

Predictions?

Action Twister



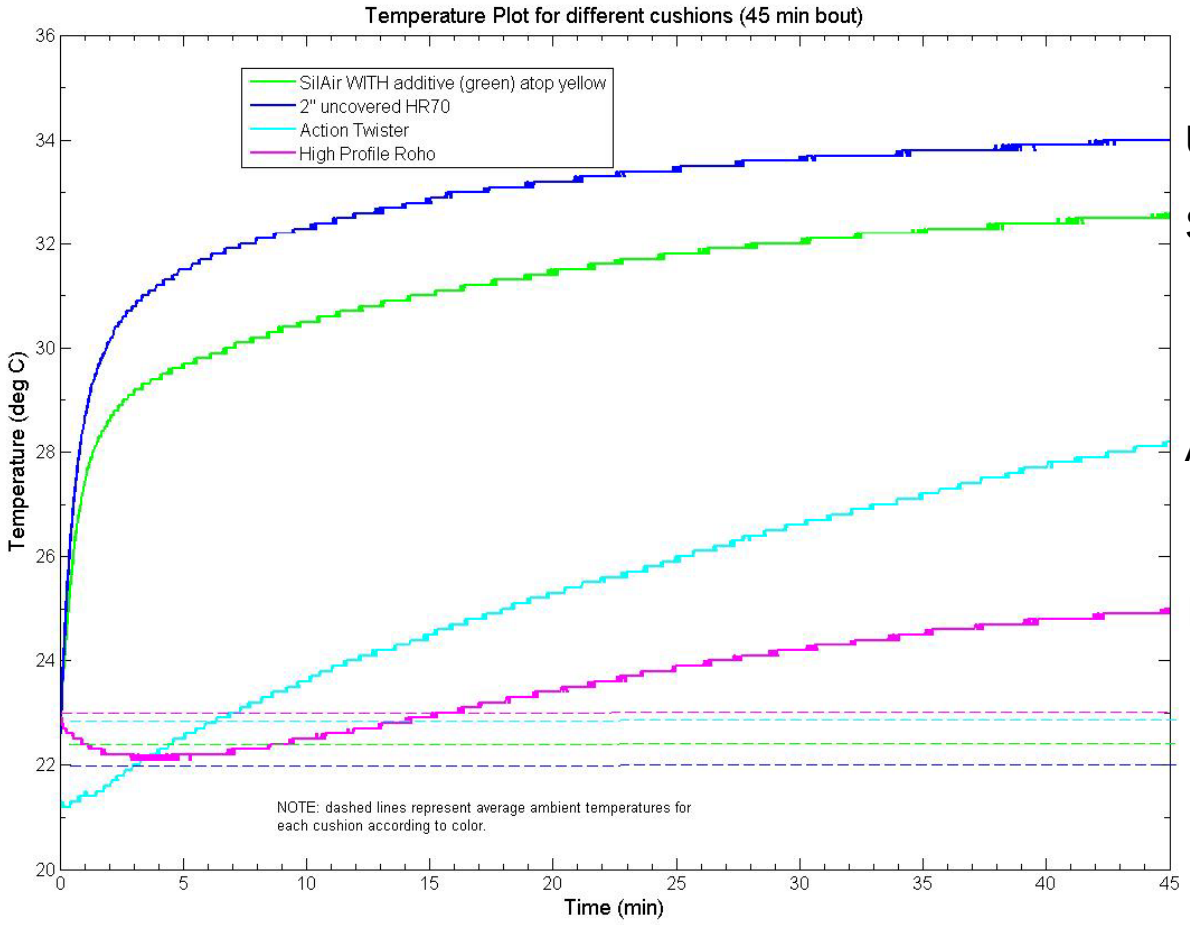
Hi Profile Roho

Polyurethane foam

Silicone-impregnated foam

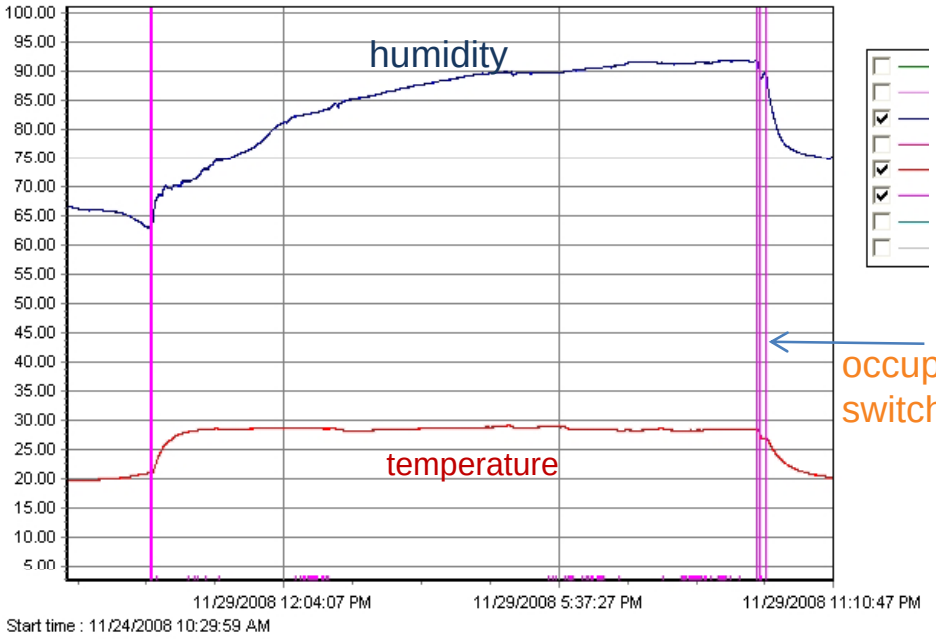
Controlled interface temperature measurements

Same subject; same clothes, same room



Monitoring in everyday life

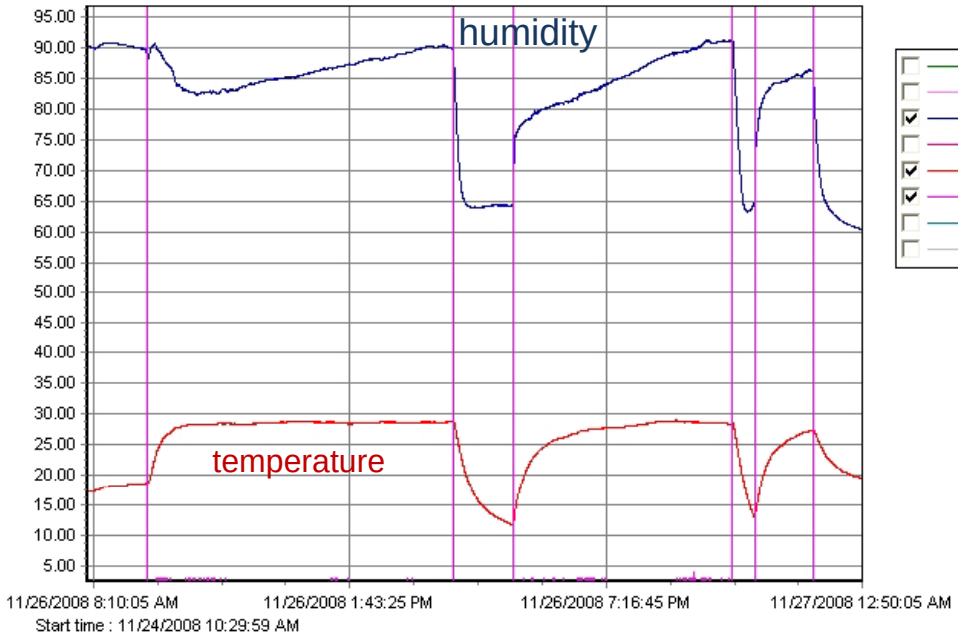
- Attached logger and sensors
  - Everything fit within cover, on the side
- Monitor for 1 week
  - Occupancy switch and debriefing help contextualize data



occupancy switch lines

One long bout
Up @ 10:30- down at 11:30

Same person
Two different days

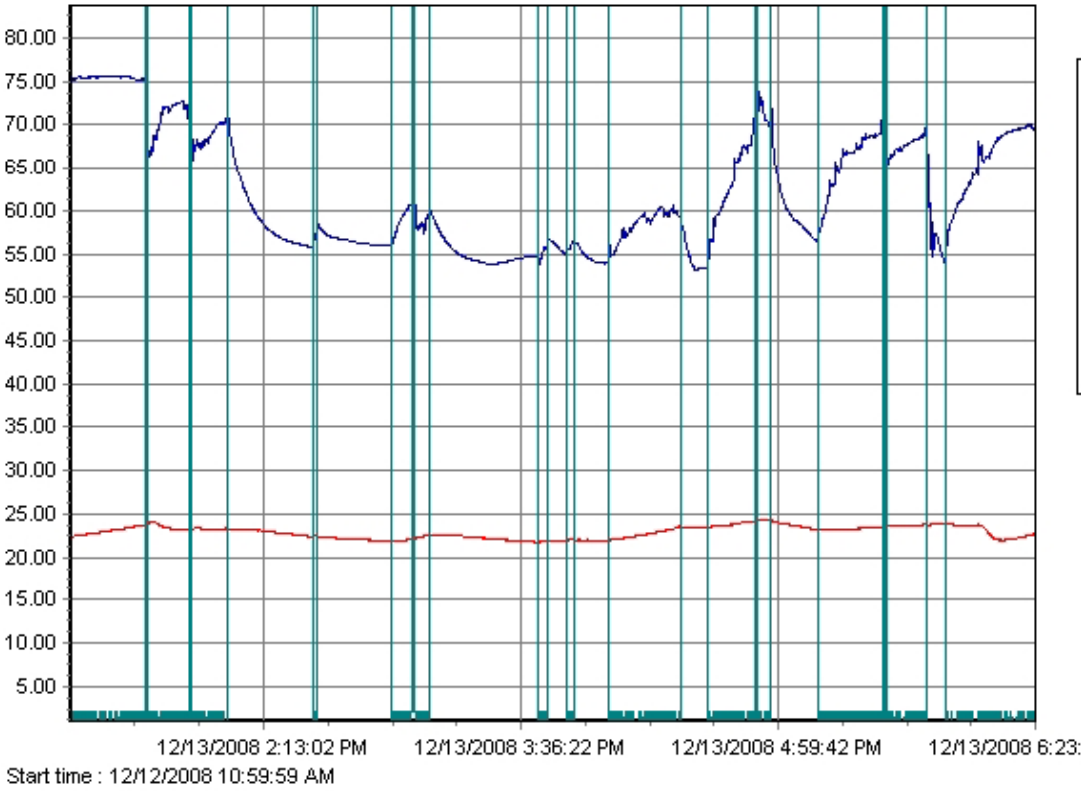


Long day, 3 bouts
No PRs
Up @ 8 am – down @ 1am

In both instances
Humidity hit 90%
Temperature peaked <30° C
BUT
Sitting bouts were very long

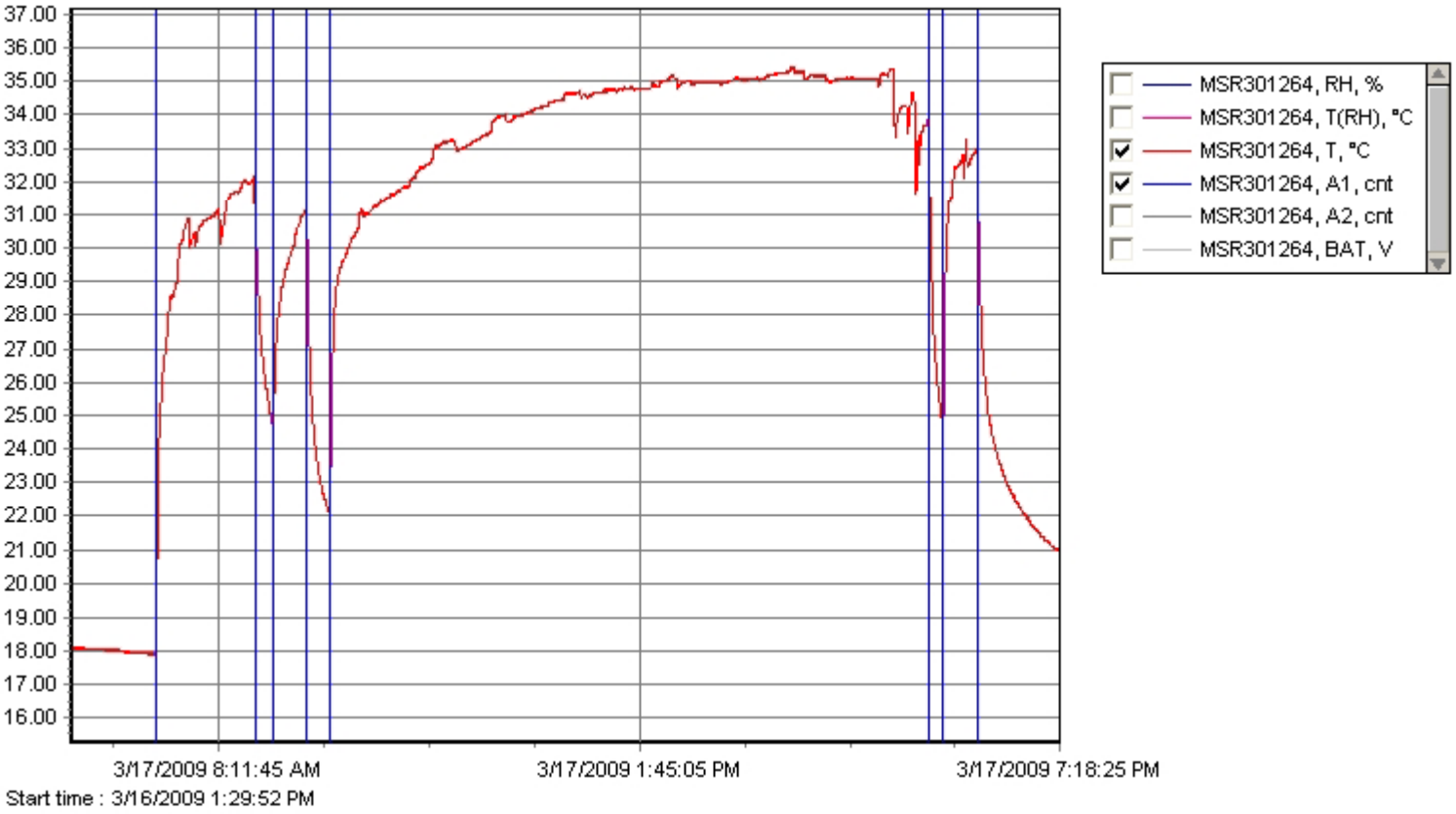
Data including many off-loading episodes

A 5-hour block



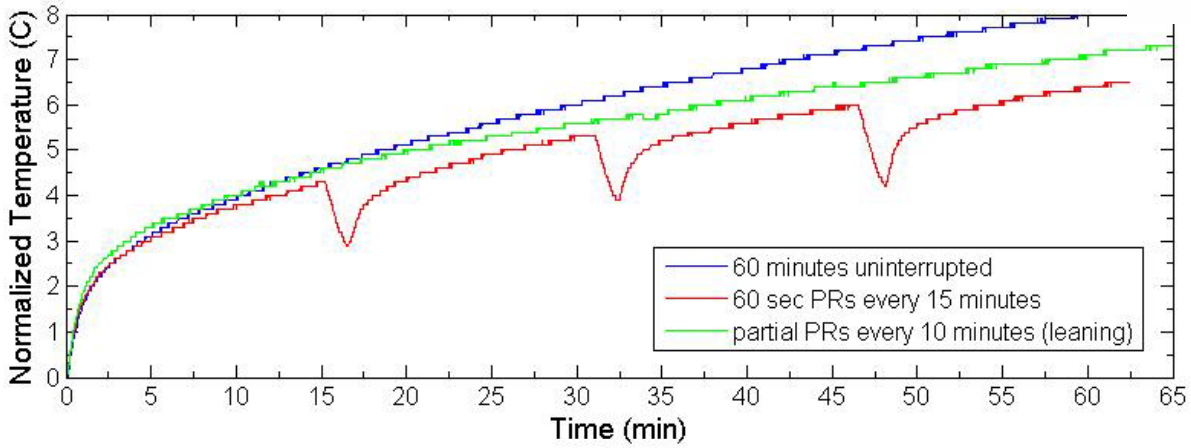
day	average bout length (min)	total occupancy (min)
1	34.51	483.17
2	39.60	712.75
3	34.53	552.42
4	33.03	495.50

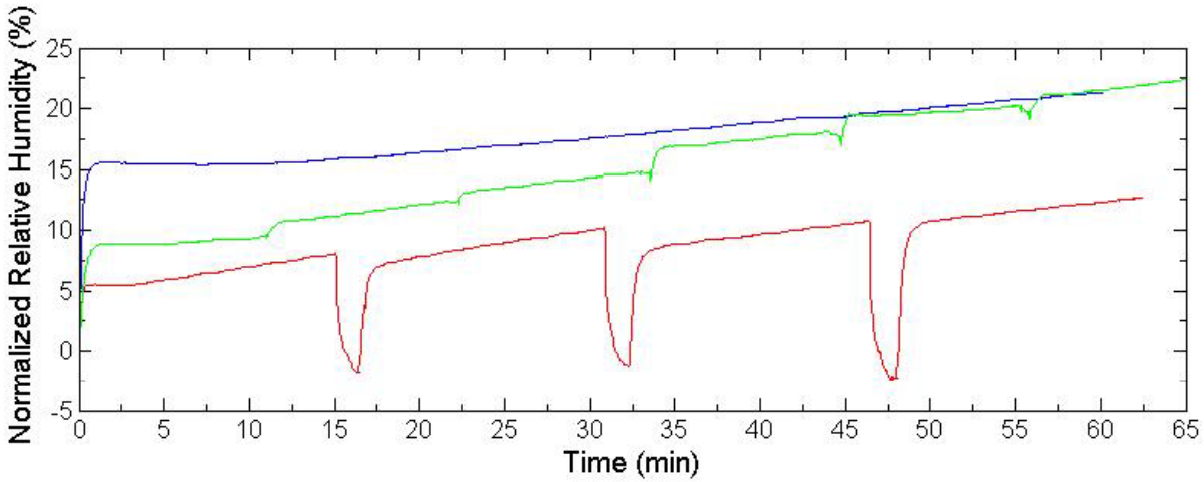
Single day: Long bout sandwiched between PR activities



Does movement matter?
Controlled testing- Action Exact cushion

Skin-mounted sensor





Why should we care?

- Tissue microclimate is important
- Cushions vary widely in microclimate management just like they vary widely in pressure management
- Moving is a good thing
  - unweights tissue so dissipates heat & alters normal and shear loading
  - Facilitate movement via education, proper positioning, bribes, threats
- If client reports sweating, we should seek other solutions
  - Shear, friction and temperature implications
- Pressure reliefs have at least 2 purposes:
  - Alleviate pressure and dissipate heat

Thanks & questions